Faculty of Resource Science and Technology

DIVERSITY OF FERN SPECIES IN DIFFERENT ECOSYSTEM TYPES: CASE STUDY AT GUNUNG JAGOI, BAU, SARAWAK, MALAYSIA

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Plant Resource and Management Programme

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APPROVAL SHEET

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Title of Dissertation: Diversity of Fern Species in Different Ecosystem Types: Case Study at Gunung Jagoi, Bau, Sarawak, Malaysia

"I declare that I have read this work and in my opinion this work is adequate in terms of scope and quality for the purpose of awarding a Bachelor's Degree of Science with Honours (Plant Resource and Management Programme)."

Signature :……

Supervisor's name : Prof. Dr. Gabriel Tonga Noweg

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Signature :……

Coordinator's name : Dr. Siti Rubiah Binti Zainudin

Date :

DECLARATION

I declare that no portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

……..

(SITI NURLATIFAH BINTI SALEHHUDIN)

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LIST OF ABBREVIATIONS

e.g.	example
fig.	Figure
GPS	Global positioning system
Gng.	Gunung
Kch	Kuching
Kpg.	Kampung
MDF	mixed dipterocarp forest
sp.	a single species
UNIMAS	Universiti Malaysia Sarawak

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Diversity of Fern Species in Different Ecosystem Types:
Gunung Jagoi, Bau, Sarawak, Malaysia

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ABSTRACT

A study using plot sampling method to determine the diversity and distribution of fern species in two different forest types: kerangas forest and mixed dipterocarp forest (MDF) in Gunung Jagoi have been carried out. In kerangas forest, a total of 2,251 individuals belonging to nine different families and in MDF, a total of 2,844 individuals belonging to 13 different families have been recorded. Analysis on the importance values (I_v) of fern species was enumerated and quantified the dominant and the least dominant species. In kerangas forest, the dominant fern species is *Selaginella canaliculata* and least dominant species is *Metathelypteris flaccida*. Whereas in MDF, the dominant species is *Coniogramme fraxinea* and least dominant species is *Sphaerostephanos porphyricola*. The distribution of fern species also has been identified based on the relative frequency for all established plots in different elevation.

Key words: diversity, distribution, elevation, fern, forest

ABSTRAK

Satu kajian menggunakan kaedah plot 5 × 5 m untuk mengenal pasti nilai kepelbagaian dan taburan paku-pakis di dua jenis hutan yang berbeza di Bau, iaitu hutan kerangas dan hutan Dipterocarp telah dijalankan. Di hutan kerangas, 2,251 individual daripada sembilan famili berlainan dijumpai dan hutan Dipterocarp, sejumlah 2,844 individual daripada 13 famili berlainan telah direkod. Di dalam hutan kerangas, Selaginella canaliculata adalah spesis yang dominan dan Metathelypteris flaccida adalah spesis yang kurang dominan manakala bagi hutan Dipterocarp pula, species dominan ialah Coniogramme fraxinea dan kurang dominan ialah Sphaerostephanos porphyricola. Taburan paku-pakis juga telah dikenal pasti berdasarkan relatif frekuensi di setiap ketinggian yang berbeza.

Kata kunci: kepelbagaian, taburan, ketinggian, paku-pakis, hutan

CHAPTER 1

INTRODUCTION

Mount Jagoi is located 35 km southwest of Kuching City in Bau District. Mount Jagoi which sits almost at the top of this mountain is the ancestral village of the Jagoi Bidayuhs (Andrew et al., 2011). The 13 dilapidated houses and ceremonial center is the only reminder of the glorious past culture of these peoples as most moved downhill some 50 years ago to 8 villages around the mountain (Andrew et al., 2011). According to the historical recorded, Mount Jagoi had provided settlement to the Jagoi Bidayuhs, a place to hunt and collect forest products in addition to practice shifting agriculture for more than 600 years. It still has more than 400-hectare of undisturbed forest. Apart from supplying clean water to the villagers, this remnant forest is the only pristine tropical rainforest in the area purportedly housing rich biodiversity (Andrew et al., 2011).

Malaysia is developing country with an economy based on forest exploitation, plantation agriculture and mining (Whitmore, 1975). Expansion of these industries has resulted in extensive environmental changes. Much of lowland forest has been felled and replaced by rubber and oil palm plantations (Van Steenis & Holttum, 1982). Large areas have been denuded during the extraction of tin ore, mangroves swamps have been drained and forests in the hills have been logged (Piggott,1988). The present distribution of the Malaysian flora reflects the changes that have taken place in the environment. Those plants which grow in shade and high humidity have become less widely distributed and less common as their habitats have been reduced (Allen, 1963). Plants preferring more open situations with plenty

of sunlight have spread and become more common as suitable habitats developed (Copeland, 1960).

Ferns are commonly considered to be plants of damp shady places. Many of them are, and their numbers in peninsula have decreased but many other ferns are adapted to exposed and less humid situations, and their numbers have increased (Holttum, 1966). It is difficult to indicate the relative abundance of species. Those growing terrestrial in open places present few problems, but the numbers of those in deep shade in the forest are less easy to estimate. Others have stringent requirements, and grow only where all of these are met (Piggott, 1977). Such habitats may occur infrequently but, where they do, the fern is often abundant. Some grow in inaccessible places, such as the crowns of tall trees or high on cliffs and rarely seen (Stone, 1981). Some fern fronds closely resemble the leaves of seed-bearing plants and are not easily distinguished. A few are so small that they may frequently be overlooked (Holttum, 1966).

From time to time, new fern species are found in Malaysia by botanist. They may have existed in those habitats without being discovered and recognized. Ferns are integral part of the world's flora, appreciated for their beauty as ornamental, problematic as invaders, and endangered by human interference (Ridley, 1925). They often dominate forest understories, but also colonize open area, invade waterways and survive in nutrient-poor wastelands and eroded pastures (Piggott, 1979).

As ferns are considered as wild plant, they have been used widely for food among the traditional Bidayuh community. As time passed by, these kinds of plants are gradually being

forgotten of their values except for a few species. Mount Jagoi is very rich in terms of these plants that are yet to be uncovered (Andrew et al., 2011). As such, this research is:

1. To assess the diversity of ferns in Mount Jagoi, according to the different forest types: Kerangas Forest and Mixed Dipterocarp Forest.

2. To estimate the distribution of the species of ferns that is found in the area by altitude based on relative frequency.

3. To document all species in the area to contribute to the overall biodiversity data base collection being carried out by the Jagoi Development Committee.

CHAPTER 2

LITERATURE REVIEW

2.1 Mountain as hot spots of ferns diversity.

On the mountains, there are same ecological classes of ferns as in the lowlands such as sun and shade ferns, climbers and epiphytes. The fern flora of mountains is more luxuriant, because there is greater atmospheric moisture, clouding and mist being more frequent than in the lowlands and also forest streams are more frequent in the mountains and there are always ferns near streams (Burgess, 1969).

Tree-ferns are far more abundant on the mountains than in the lowlands, and also larger (Holttum, 1967). Some of them are only found in the shade of the forest, or beside streams, but the largest and most beautiful (*Cyathea contaminans*) grows more luxuriantly near the edge of the forest, where crown can be exposed to the sun (Allen, 1969). These ferns sometimes grow in such abundance that they form groves where clearing have been made: their shade probably helps in the re-establishment of forest plant (Holttum, 1967). Tree-ferns, unlike ordinary trees, cannot increase the thickness of their trunk as they grow taller, and so in time they outgrow their strength (Johnson, 1977).

2.2 The ecology of Malayan Ferns

Ecology is the study of the relations between a plant or animal and its environment (Dobbie, 1963). Environment for a fern is the soil in which it roots, the light that shines on its leaves, the rain, the wind, changes of temperature, and other such things, and the other plants that grow around it (Foo, 1957). Some ferns not grow continuously; it is probably connected

with climatic changes, of drought or rain (Piggott, 1979). Ferns are divided into a few classes which is according to the conditions under which they grow. First come those which root in more or less level ground, and do not climb trees; these kind of species are divided into sun- and shade-ferns (Holttum, 1981). There are climbing ferns which start life on the ground then it will climb the tree, sometimes only a little way, sometimes to a great high (Burkill, 1935). Next, the ferns that live on trees, not on the ground (epiphytes). These species are divided into those living in shady places. The latter show many different adaptations to their peculiar conditions (Piggott, 1977). Then, there are also river-side and rock-ferns, which are usually different from the terrestrial ferns of the forest, and there are a few aquatic ferns (Allen, 1963). Finally, there are ferns on the high mountain ridges.

2.3 The Geography of Ferns

According to the Hanbury-Tenison (1979), there are perhaps 10,000 species of ferns in the whole world. In Malaya there are about 500, which is considerable percentage if reflect the area of Malaya is only about one thousandth of the total land area on the Earth. The reasons for this abundance lie in the particularly favorable climate of Malaya. The climate did not produce the ferns but it enabled them to flourish when they arrived here, and it provided suitable conditions for their evolution, for establishment of new kinds of ferns (Copeland, 1960).

A large proportion of Malayan ferns are widely distributed in Malaysia, but not beyond Malaysia except in some cases a less or greater distance into the pacific (Piggott, 1981). According to the previous study, there are still other ferns are only found in Western Malaysia (Sumatra, Malaya, Borneo and Java). Some are only known to occur either Borneo or Sumatra

and Malaya, and a few only in Malaya. These latter classes are in all cases rather uncertain, as botanical exploration of Western Malaysia is still far from complete (Holttum, 1977).

CHAPTER 3

METHADOLOGY

3.1 Study site

Field work was being conducted at several locations within the Mount Jagoi complex in Bau district (Fig 1). Mount Jagoi is situated 35km from Kuching city. The communities that lived up in these areas are mostly made up of the Bidayuh people. There were two forest sites which were conducted in this study. There were the Kerangas forest and Mixed Dipterocarp Forest (MDF). Methods that were used in this study are systematic sampling plot method and transect survey method. Systematic sampling allowed the calculation of the diversity of ferns that are found at Mount Jagoi while transect survey further enriched the data collection and allowed the study of species distribution according to altitude.

Fig 1: Study site at Kpg. Jagoi area, Bau, Sarawak

3.2 Materials: Study Equipments

The sampling and measuring equipment that were used during the study research were measuring tape (50 meter), chopper and recording sheets. For the sampling method, nylon rope was used as markers for making sampling site borders. Besides, a GPS (Global Positioning System) device was also used to determine the location of the baseline and borders for sampling site.

3.3 Study design and data collection

3.3.1 Sampling method

A. Transect survey method

This method was used during the surveying of the ferns species along the main trails to Mount Jagoi. Fern species found on both side within 5m strip on was recorded. The survey was done at different altitude (low altitude, middle altitude and high altitude). The data of ferns that were found in the area were recorded in the prepared data sheet.

B. Systematic plot sampling method

The sites of sampling plots were determined systematically. Sampling plots of 5m X 5m were systematically laid out along a pre-determine baseline in each of the forest types (Kerangas Forest and Mixed Dipterocarp Forest). The plots were set up 5m away from the baseline to avoid disturbance while the distance from one plot to one plot is 50m (Fig. 1). The coordinates of the plot were also being taken using a GPS to allow future revisit to the site. Similar to the transect survey method. The data collected were recorded in the data sheet.

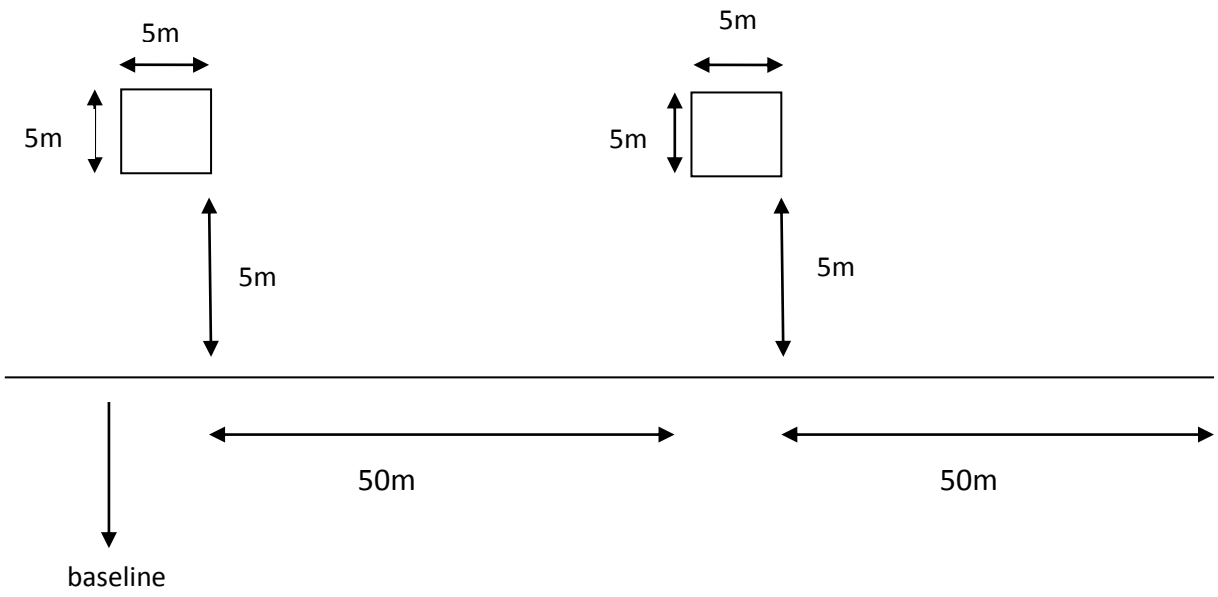

Fig 2: Systematic sampling plot design

3.3.2 Field visit and data collection

The plant collection and identification were carried out based on the work schedule plans. The identification of the ferns species using their local name (vernacular name) were carried out with assistance of local villagers. The scientific name for each of the ferns species found was provided by an expert person once the process finished. In order to ensure the accuracy of the data, various expert people or organizations were involved in this study. They include officers from UNIMAS, Sarawak Forestry Cooperation and The Sarawak Forest Department. Besides that, available references and manuals also were be used. For unidentified specimens, they were processed and identified at the UNIMAS herbarium or herbarium of Sarawak Forestry Cooperation (SFC).

3.4 Data analysis

3.4.1 Relative density (R_d)

Species density is closely related with the species abundance in the study area. The higher the density value, the more abundant number of the species present in that area. Relative density (R_d) reveals the abundance of species in term of number of individual. The formula for calculating relative density (Rd) is shown as below:

$$R_d\ (\%) = \frac{\text{Number of individual of particular species}}{\text{Total number of individual of all species}} \times 100$$

3.4.2 Relative frequency (R_f)

Species frequency is defined as the percentage of plots in which a species is being found. It shows the density of species based on distribution of species in the forest. To determine the relative frequency (R_f) in an area, the given formula is used:

$$R_f = \frac{\text{Total no. of individual of particular species}}{\text{Total no. of occurrence of all individual species in all plots}} \times 100$$

3.4.3 Influence of altitude on species distribution

Relative density (R_d) and relative frequency (R_f) of the key species were compared between plots at different altitude (50masl, 200masl and 350masl). It is expected that certain species will be more significant in term of the two parameters. The significance of the differences are also tested.

CHAPTER 4

RESULTS

Based on the results obtained, there were two components included in this study which are diversity of ferns species in different forest types (Kerangas Forest and MDF) and the distribution of ferns species that is found in different altitude based on relative frequency.

4.1 Diversity of fern species in Kerangas Forest

Fifteen plots in Kerangas forest were established and a total of 2,251 individuals were recorded. There were 9 families found in the fifteen plots. Table 1 shows the relative frequency, relative density and importance value for each species found in the established plots. In Plot 1, a total of 64 individual ferns from four different families were recorded. *Selaginella caniculata* represents the dominant species with I_v of 98.96 and followed by *Pronephrium asperum, Christella parasitica* and *Asplenium phyllitidis*. The least dominant species in this plot was *Cyathea alternans* with I_v of 13.02. In Plot 2, a total of 369 individual ferns from seven different families were recorded. *Syngramma wallichii* represents the dominant species with I_v of 53.07 and followed by *Lygodium circinnatum, Pronephrium asperum* and *Selaginella canaliculata*. The least dominant species in this plot was *Blechnum Oriental* with I_v of 14.48. In Plot 3, a total of 206 individual ferns from six different families were recorded. *Syngramma wallichii* represents the dominant species with I_v of 71.55 and followed by *Lycopodium cernuum, Asplenium nidus* and *Lygodium circinnatum.* The least dominant species identified in this plot was *Blechnum Oriental* with I_v of 10.12. In Plot 4, a total of 66 individual ferns from three different families were recorded. *Dicranopteris linearis* represents the dominant species with I_v of 85.61 and followed by *Syngramma wallichii* and

Blechnum orientale. The least dominant species in this plot was *Coniogramme fraxinea* with I_v of 29.55. In Plot 5, a total of 55 individual ferns from five different families were recorded. *Dicranopteris linearis* represents the dominant species with I_v of 74.55 and followed by *Lygodium circinnatum, Blechnum orientale* and *Coniogramme fraxinea*. The least dominant species found in this plot was *Selaginella canaliculata* with I_v of 12.73. In Plot 6, a total of 113 individual ferns from four different families were recorded. *Dicranopteris linearis* represents the dominant species with I_v of 73.53 and followed by *Blechnum orientale, Syngramma wallichii* and *Coniogramme fraxinea*. The least dominant species found in this plot was *Selaginella canaliculata* with I_v of 11.75. In Plot 7, a total of 72 individual ferns from four different families were recorded. *Dicranopteris linearis* represents the dominant species with I_v of 88.89 and followed by *Syngramma wallichii, Blechnum orientale* and *Cyathea moluccana*. The least dominant species found in this plot was *Coniogramme fraxinea* with I_v of 15.28. In Plot 8, a total of 97 individual ferns from seven different families were recorded. *Dicranopteris linearis* represents the dominant species with I_v of 47.34 and followed by *Lycopodium cernuum, Lygodium circinnatum* and *Blechnum orientale*. The least dominant species found in this plot was *Coniogramme fraxinea* and *Selaginella canaliculata* with I_v of 10.79 and 9.75 respectively. In Plot 9, a total of 82 individual ferns from seven different families were recorded. *Dicranopteris linearis* represents the dominant species with I_v of 69.96 and followed by *Blechnum orientale, Syngramma wallichii* and *Lygodium circinnatum*. The least dominant species in this plot was *Coniogramme fraxinea* with I_v of 12.75. In Plot 10, a total of 208 individual ferns from seven different families were recorded. *Coniogramme fraxinea* represents the dominant species with I_v of 38.43 and followed by *Syngramma wallichii, Selaginella canaliculata* and *Dicranopteris linearis*. The least dominant species in this plot was *Metathelypteris flaccida* with I_v of 8.29.

Table 1: Relative frequency (R_d), relative density (R_f) and importance value (I_v) of ferns species in Kerangas Forest

Plot	Species	Rf (%)	Rd (%)	I_v
1	*Selaginella canaliculata*	33.33	65.62	98.96
	Asplenium phyllitidis	16.67	4.69	21.35
	Pronephrium asperum	25.00	12.50	37.50
	Cyathea alternans	8.33	4.69	13.02
	Christella parasitica	16.67	12.50	29.17
2	*Asplenium nidus*	11.77	5.42	17.19
	Blechnum Oriental	11.77	2.71	14.48
	Dicranopteris linearis	11.76	8.40	20.17
	Lygodium circinnatum	17.65	23.04	40.68
	Pronephrium asperum	11.77	17.34	29.11
	Selaginella canaliculata	11.77	13.55	25.32
	Syngramma wallichii	23.53	29.54	53.07
3	*Asplenium nidus*	23.08	9.22	32.30
	Blechnum Oriental	7.69	2.43	10.12
	Dicranopteris linearis	7.69	3.88	11.58
	Lycopodium cernuum	15.38	30.10	45.48
	Lygodium circinnatum	15.38	13.59	28.98
	Syngramma wallichii	30.77	40.78	71.55
4	*Blechnum orientale*	25.00	12.12	37.12
	Coniogramme fraxinea	12.50	4.55	29.55
	Dicranopteris linearis	37.50	60.61	85.61
	Syngramma wallichii	25.00	22.73	47.73
5	*Blechnum orientale*	18.18	7.27	25.46
	Coniogramme fraxinea	9.09	5.45	23.64
	Dicranopteris linearis	18.18	56.36	74.55
	Lygodium circinnatum	27.27	23.64	41.82
	Selaginella canaliculata	9.09	3.64	12.73
	Syngramma wallichii	18.18	3.64	21.82